Message

From: Whittier, Robert [Robert.Whittier@doh.hawaii.gov]
Sent: 7/20/2021 6:56:13 PM
To: g.d.beckett@aquiver.com; Grange, Gabrielle Fenix [gabrielle.grange@doh.hawaii.gov]; Ichinotsubo, Lene K [lene.ichinotsubo@doh.hawaii.gov]; Matt Tonkin [matt@sspa.com]
CC: Tu, Lyndsey [Tu.Lyndsey@epa.gov]
Subject: Re: [EXTERNAL] RE: Matt, could you clarify 3 explanations of low gradients at tank farm
Attachments: Borescope_SOW_V2.docx

Hi All,

I sent the wrong SOW. Here is the one I intended to send that has much more detail.

Sorry about the confusion,

Bob W.

From: Whittier, Robert <Robert.Whittier@doh.hawaii.gov>
Sent: Thursday, July 15, 2021 4:52 PM
To: g.d.beckett@aquiver.com <g.d.beckett@aquiver.com>; Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>; Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>; 'Matt Tonkin' <matt@sspa.com>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>
Subject: Re: [EXTERNAL] RE: Matt, could you clarify 3 explanations of low gradients at tank farm

Hi All,

For the borescope study, attached is a SOW I developed some time back. It was based a pretty in-depth review of available literature.

Thanks,
Bob W.

From: g.d.beckett@aquiver.com <g.d.beckett@aquiver.com>
Sent: Thursday, July 15, 2021 2:07 PM
To: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>; Whittier, Robert <Robert.Whittier@doh.hawaii.gov>; Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>; 'Matt Tonkin' <matt@sspa.com>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>
Subject: [EXTERNAL] RE: Matt, could you clarify 3 explanations of low gradients at tank farm

Hi folks,

In our original scope, wells would be tested at more than one interval based on the TCD & dilution tests. The water table is a given, the behavior across the well screen would determine the other intervals. Halawa deep observation well could be interesting since we already have a TCD and video log, if my memory is correct about what Don T. described (Don, let me know if I've got that wrong).

The borescope tests will be of limited use if only one interval is tested because we will not then know if there is variability even across a ~15-ft well screen. Given the scale of the lithologic fabric, I would hypothesize that we will see

some variations across even that small interval (though we can't likely capture the full aquifer variance). But then again, our tracer test (if warranted) will be at that upper aquifer level.

Best regards

From: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>
Sent: Thursday, July 15, 2021 3:37 PM
To: Whittier, Robert <Robert.Whittier@doh.hawaii.gov>; Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>; Matt Tonkin <matt@sspa.com>; g.d.beckett@aquiver.com
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>
Subject: RE: Matt, could you clarify 3 explanations of low gradients at tank farm

Thanks, everyone! So glad to have all your talented brainpower at work on this.

Sorry, G.D, I inadvertently left you off my initial question to Matt.

Fenix

From: Whittier, Robert <Robert.Whittier@doh.hawaii.gov>
Sent: Thursday, July 15, 2021 11:25 AM
To: Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>; Matt Tonkin <matt@sspa.com>; Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>
Subject: Re: Matt, could you clarify 3 explanations of low gradients at tank farm

Hi All,

Let me put my feet up on my desk and think about this for a bit.

You have to excuse me I have 33 MHz brain in a 12 GHz world.

Thanks,
Bob W.

From: Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>
Sent: Thursday, July 15, 2021 10:07 AM
To: Matt Tonkin <matt@sspa.com>; Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>; Whittier, Robert <Robert.Whittier@doh.hawaii.gov>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>
Subject: RE: Matt, could you clarify 3 explanations of low gradients at tank farm

Hi Matt/Bob,
Given these scenarios, would you recommend changes to the planned in-well testing? The in-well testing will help identify at least the velocity and direction in the upper aquifer (limited by well screen interval). Would it be worth running the borescope test at least two different depths in each well or is the well screen depth too shallow to accommodate this effectively? If the latter is true, I believe we started discussion on the possibility of another well near the upper tanks of the tank farm. If this well is drilled, then we could drill a bit deeper and run the colloidal test at a deeper depth before installing the well (if borehole can stay open). Would this help get the information needed?

From: Matt Tonkin <matt@sspa.com>
Sent: Thursday, July 15, 2021 6:11 AM

To: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>; Whittier, Robert <Robert.Whittier@doh.hawaii.gov>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>; Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>
Subject: [EXTERNAL] RE: Matt, could you clarify 3 explanations of low gradients at tank farm

Hi Fenix:

In general terms this reflects my evolution in thinking yes. Along the way, in the past, Bob and I had in general terms worked with two simplified alternatives I think just to keep the possible contrasts in mind:

1. In the upper aquifer - very highly transmissive, and large flows, which would result in relatively small capture due to high aquifer fluxes.
2. In the upper aquifer - lower transmissivity and lower flows, which would result in potentially larger capture due to the lower aquifer fluxes (or, in water at RHS having to come from somewhere else)

[Note there is of course a spectrum here – it could also be highly transmissive and relatively low flows; but what it *cannot* be is moderate/low transmissivity and uniform high unidirectional flows)

That said, Bob and I had discussed that as the conceptualization becomes increasingly compartmentalized, then certainly #2 would start to behave quite differently, to the extent that the area around RHBSF might become somewhat "isolated" from the pumping at RHS, and the water RHS extracts would have to be from somewhere else. The trouble with this idea, though, is that the wells around RHBSF do show a good response to pumping at RHS, though it is simultaneously quick, and broad, but also not distinctly consistent with the classical distance-drawdown response. Furthermore, taking a time- or distance-drawdown approach to analyzing the water level data around RHBSF does seem to support a high transmissivity. But this can be extremely misleading in complex systems – a large drawdown suggests a low transmissivity, sure, but a small drawdown can represent either a high transmissivity or a compartmentalized system.

All of the above, plus the review of RHS tunnel geology and flow profile during construction, and a few other things including the wonderful presentation last week by Scott Rowland, made me think that perhaps we have a combination of systems operating at different intervals (not exactly different depths, because of the dip, but more precisely at different stratigraphic intervals). This would result in:

1. In the upper stratigraphic intervals around RHBSF, lower transmissivity and lower flows, or local pockets of high transmissivity but restricted connections laterally leading to relatively low flows (either would be consistent with the data we see)
2. In the stratigraphic intervals at and immediately below RHS, very high transmissivity and high flows (as supported by the tunnel flow log and geologic log)

In this scenario, pumping at RHS draws most of its water (>80%?) from a well connected series of clinkers that may be vertically (and laterally) distinct from the materials at the water table immediately under the RHBSF. However, because of their extent and transmissivity, those clinkers would exert a fairly broad influence, explaining the pretty rapid drawdown throughout the monitoring well network, but that inluence in terms of flows may be inhibited by having to take place via less transmissive materials (though I havent specifically dug into this, I think that stratigraphically the materials at the water table at RHBSF would be below those at RHS.) In this scenario, water from below RHBSF would probably be captured by RHS, but in an "indirect" manner via these connected clinkers, rather than in the more classic picture seen in text books.

I thought about trying to sketch something up to illustrate this, and may give it a crack. I would be very curious of Bob's thoughts on this.

Matthew J. Tonkin
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From: Grange, Gabrielle Fenix <Gabrielle.Grange@doh.hawaii.gov>
Sent: Wednesday, July 14, 2021 11:25 PM
To: Matt Tonkin <matt@sspa.com>; Whittier, Robert <Robert.Whittier@doh.hawaii.gov>
Cc: TU, LYNDSEY <Tu.Lyndsey@epa.gov>; Ichinotsubo, Lene K <lene.ichinotsubo@doh.hawaii.gov>
Subject: Matt, could you clarify 3 explanations of low gradients at tank farm

Thanks, Bob and Matt for your technical discussions today.

Matt, I was a bit confused by your three options for actual conditions under the tank and perhaps I simply misunderstood. Could you help me out?

1. Highly transmissive - huge flow and small capture?
2. Hardly any flow at surface - very high dilution from deeper flows
3. Aquifer very compartmented, disconnected in the tank farm --- less likely due to review of other nearby wells?

A quick email reply or call is fine. No rush.

Fenix Grange, M.S.
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HAWAII STATE DEPARTMENT OF HEALTH

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